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Path Coefficient and path analysis of body weight and biometric traits in Male Capoeta trutta (Heckel, 1843) in Alvand River of Kermanshah Province,(West of Iran)

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ABSTRACT: The objective of this study was to verify which morphometric measures are more directly associated with the Body weight of male *Capoetatrutta* A 126samples of male *C. trutta*from Alvand River with average body weight 314.65 g ± 11.00,were caught, weighed and their morphometric characteristics were measuted. The morphometric measures taken were: body weight (BW g), total length (TL mm), standard length (SL mm), fork length (FL mm), body height (BH mm), body width (BD mm), head length (HL mm) and snout length (SNL mm).The phenotypic correlations analysis between bodyweight and morphometric measurements showed that theTL(0.986**), SL (0.987**),FL (0.985**), BH (0.995**), BD (0.967**), SNL (0.916**) and HL (0.967**), had a significant (P<0.01) positive correlation with body weight. These correlations were later deployed in direct and indirect effects through path analysis,and the direct and indirect contributions of each variable were measured in terms of percentage. The positive highest direct effect values for body weight were SL (5.875), HL (2.688) and BD (1.033) and The highest negative direct effect value for body weight were TL (-4.821), SNL (-2.016), FL (-1.50) and BH (-0.328).The positive highest indirect Sums of effect value for body weight were TL (5.81), SNL (2.93), FL (2.49) and BH (1.32) and The highest negative indirect effect value for body weight were SL (-4.89), HL (-1.72) and BD (-0.07). the highest direct percentage values for body weight were BD (94.00%), HL (60.94%) and SL (54.59%). the highest indirect percentage values for body weight were BH (80.13%), FL (62.36%), SNL (59.52%) and TL (54.64%).indicating thatstandard length, head length and body width measurements were important for determining the body weight of male *Capoetatrutta*but, the total length, fork length and snout length had indirect effect in body weight by standard length.

***Keywords*:** morphometric, *Capoetatrutta*, direct effect, indirect effect, Alvand

INTRODUCTION

The familyCyprinidae is the largest freshwater fish family that contains a numberoflarge genera. The genus Capoetabelonging to the family Cyprinidae is characterizeda fusiform body, one-two pairs or no barbles in some species, a 3-row pharyngeal teeth, and small to medium sized scales. Most Capoeta species prefer stagnant waters and live on algae and aquatic insects. The genus Capoeta with about 20 species distributed in (south

China, North India, Turkmenistan, Aral Sea, Middle East and Anatolia Alp et al., 2005), has 7 species and 3 subspecies in Iran. In Kermanshah Province, Capoetatruttaalong with the Luciobarbusesocinus, Tor grypusand Luciobarbusbarbulus is of importance as a commercial and sport fish and can be found in local fish market places. Alvand River of Kermanshah Province is one of the important rivers of the Tigris basin in Iran and is inhabited by C. trutta. Over 30 native fish species which mostly belong to the family Cyprinidae, can be found in water resources of Kermanshah Province. After the large Luciobarbus and Tor species, C. trutta is the most important edible fish, especially for the local people living at the vicinity of the Alvand River. Breeding programs that are aimed at body yield increase present difficulties, since the direct measurement results in sacrifice of the animal and hence in the loss of a potential breeder within the group (Crepaldi et al., 2008). Correlation of body yields with morphometric measurements has been the subject of several studies for some fish species (Freatoet al., 2005), (Rafael et al.,2012 and Sang et al., 2009). However, this simple correlation only makes it possible to evaluate the direction and magnitude of the association between two characters, without providing necessary information concerning the direct and indirect effects of a group of characters in relation to a dependent variable of major importance Cruz (2001)."Path analysis" is a device that a breeding researcher can use to break the correlation of direct and indirect effects(Cruz, 2001) and (Cruz and Carneiro ,2003) through basic variables such as body yields, and explanatory variables such as morphometric ratios and measures, providing a better understanding of the reasons for the associations between these traits Costa (2011).Length-Weight Relationships and Morphometry for Eleven Fish Species from Ogudu Creek, Lagos, NigeriaE.O. (Lawson et al., 2010), Comparative Survey of MorphometricmeristicMale and Female Anjak FishSchizocyprisbrucei, Annandale and Hora, 1920 ofHamoun Wetland in South EastIran(Abbaspour et al., 2011) and Length-Weight Relationship and Condition Factor of SchizopygecurvifronsHeckel, 1838 from River Jhelum, Kashmir, India (Iqbal Mir et al., 2011) has been studied. This study used path analysis of the phenotypic correlations to verify which morphometric measures would be more directly associated with body weight of Capoetatrutta.

MATERIALS AND METHODS

Alvand River is located in west of Iran. the main reasons for the selection of *C.trutta* for this study were the abundance of the species and the lack of knowledge on its morphologic features and its commercial value. For this study at least one kilometer reach of each river was selected and sampled on a monthly basis. The sampling station was : Altitude 380m, longitude: 34° 31′ 18″ and latitude 45° 35′ 56″ . Specimens were caught monthly with gill and cast nets of various mesh sizes (1-5 cm) between August 2008 and July 2009. The samples were fixed in neutralized formalin (4%). Eight morphometric variables including body weight, total length, fork length, standard length, head length, snout length, body width, and body depth were recorded. Body weight was measured with the nearest 0.1 gr. The phenotypic correlation coefficients were computed and the path coefficient analysis was performed using phenotypic correlations to assess direct and indirect effect of morphometric traits on body weight using SAS9.2, Path 2 and SPSS 20 software's.

RESULTS AND DISCUSSION

The Spearman's rank correlation coefficient between body weight and morphometric measurements were calculated (Table 1).The results indicated that the male total length (0.986**),standard length(0.987**),fork length(0.985**), body height(0.995**), body width(0.967**), and snout length(0.916**) and head length(0.967**), had a significant (P<0.01) positive correlation with body weight (Table 1). Correlation of body yields with morphometric measurements had been the subject of several studies for some fish species and This result reported by other authors: (Rafaelet al.,2012) found significant phenotypic correlations between body height with a value of 0.83, head length with a value of 0.48, BD/HL with a value of -0.26 and BD/SL with a value of -0.16 by body weight in pacuPiaractusmesopotamicus, tambaquiColossomamacropomum and their hybrids, (Nasri-tajan and Taati,2010), found correlation coefficient with a value of 0.74 between body weight and total length in (Cynoglossusarel, Johariet al., 2010), found correlation coefficient with a value of 0.967 between body weight and total length in female Capoetatrutta, (Nasri-tajan and Taati, 2010) found correlation coefficient with a value of 0.94 between body weight and fork length in female Scardiniuserythrophthalmus, (Sang et al., 2009), also reported that

body measurements were effective in the estimation of weight and body yield in catfish Pangasianodonhypophthalmus, (Barbosa et al., 2008), found standard length as the measure most correlated with a value of 0.93 with live weight, in tilapia, (Charo-Karisa et al., 2007), found significant phenotypic correlations ranging between 0.64 and 0.89 between body measurements and weight of tilapia, (Freato et al., 2005), found correlation coefficient with a value of 0.89, 0.89 and 0.92 between standard length, height and body circumference weight of piracanjubaBryconorbignyanus and(Rutten et al., 2005), found correlation coefficient with a value of 0.76 and 0.91 between height and width with body weight in tilapia.

The stepwise procedure resulted in the inclusion of the following morphometric measures: Body weight = TL, SL, FL, BD, BH, SNL and HL.

Rafael*et al.*(2012) reported the equation in*pacuPiaractusmesopotamicus*, *tambaquiColossomamacropomum* and their hybrids as WEIGHT = HL, BH, BD, BH/SL, BD/SL, BD/HL; carcass yield = HH, BH, BD, HH/SL, HL/BH, BD/BH; RCOST = HH/SL, BH/SL, BD/SL, HH/BH, BD/HL; filet with rib yield = HH, BD/SL, HL/HH, BD/HL; filet yield = HH, HL/HH, BD/HL , Johari*et al.*(2010) reported the equation of body weight in female *Capoetatrutta*, as total weight = -11.78+3.107total length, (Nasri-tajan and Taati, 2010) reported the equation of body weight in female *Cynoglossusarel* as total weight= 0.494×total lenght$^{1.598}$ and (Nasri-tajan and Taati, 2010) reported the equation of body weight in female *Scardiniuserythrophthalmus*, as total weight = 0.0000056 ×f lenght$^{3.205}$.

Table 1. Correlation coefficients, direct and sums of the indirect effects, and Percentages of direct and indirect effects of morphometric measurements with body weight ofCapoeta in AlvandRiver

Variables	Correlation coefficient	P value	Direct effects	Sums of indirect effects	% direct effects	% indirect effects
TL	0.986	0.000	-4.821	5.81	45.36	54.64
SL	0.987	0.000	5.875	-4.89	54.59	45.41
FL	0.985	0.000	-1.5	2.49	37.64	62.36
BD	0.967	0.000	1.033	-0.07	94.00	6.00
BH	0.995	0.000	-0.328	1.32	19.87	80.13
SNL	0.916	0.000	-2.016	2.93	40.75	59.25
HL	0.967	0.000	2.688	-1.72	60.97	39.03

Morphometric measurements: total length (TL mm), standard length (SL mm), fork length (FL mm), body height (BH mm), body width (BD mm), head length (HL mm) and snout length (SNL mm)

Table 2 . Estimates of direct and indirect effects, obtained by path analysis, between the morphometric measurements and ratios and body weight of Capoeta in AlvandRiver

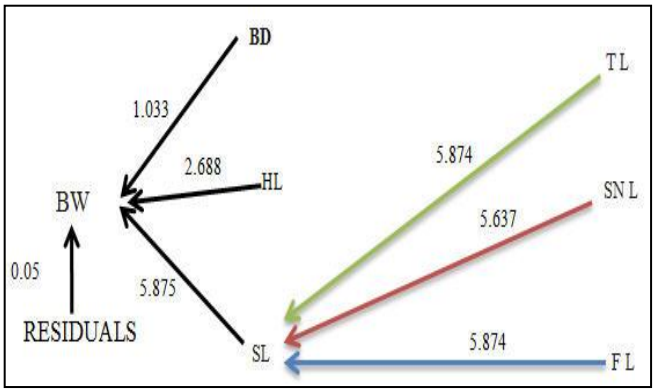
Effects	TL	SL	FL	BD	BH	SNL	HL
Direct	-4.821	5.875	-1.5	1.033	-0.328	-2.016	2.688
In direct by TL	----	5.874	-1.500	1.026	-0.325	-1.935	2.667
In direct by SL	-4.821	----	-1.500	1.026	-0.325	-1.934	2.666
In direct by FL	-4.821	5.874	----	1.026	-0.325	-1.937	2.669
In direct by BD	-4.786	5.833	-1.490	----	-0.320	-1.987	2.684
In direct by BH	-4.775	5.827	-1.484	1.008	----	-1.871	2.619
In direct by SNL	-4.628	5.637	-1.442	1.019	-0.305	----	2.650
In direct by HL	-4.785	5.829	-1.489	1.032	-0.320	-1.987	----

Morphometric measurements: total length (TL mm), standard length (SL mm), fork length (FL mm), body height (BH mm), body width (BD mm), head length (HL mm) and snout length (SNL mm)

The positive highest direct effect values for body weight in male Capoetatrutta were standard length(5.875), head length(2.688) and body width(1.033) and the highest negative direct effect values for body weight were total length (-4.821), snout length(-2.016), fork length(-1.50) and body height(-0.328).the positive highest indirect Sums of effect values for body weight were total length (5.81), snout length(2.93), fork length(2.49) and body height(1.32) and the highest negative indirect effect values for body weight were standard length(-4.89), head length(-1.72) and body width(-0.07) (Table 2). the highest direct percentage values for body weight in male Capoetatrutta, were body width (94.00%), head length(60.94%) and standard length (54.59%). the highest indirect percentage values for body weight were body height(80.13%), fork length(62.36%), snout length(59.52%) and total length (54.64%), (Table 1). indicating that standard length, head length and body width had direct effect also the total length, fork length and snout length had indirect effect in body weight by standard length. is important in determining body weight in male Capoetatrutta[Fig. 1]. Path analysis of body yields with morphometric measurements has been the subject of several studies for some fish species. (Rafael et al.,2012) reported that body measurements were effective in the estimation of weight and body yield inpacu Piaractusmesopotamicus tambaquiColossomamacropomum and their hybrids. They found a direct effect of HL with a value of (1.232 and 62.09%),BH with a value of (0.353 and 42.53%) and BD with a value of (0.875 and 57.72%). Serafini(2010), evaluating the performance, along with morphometric and carcass traits of tambaqui, pacu and their hybrids, observed a superiority for the final weight of tambaqui and the hybrid tambacu in comparison with (pacu.Serafini,2010) observed that fish with a higher carcass percentage tambaqui and tambacu also have the largest head measures, reinforcing the path analysis results, i.e., fish with larger head size, or with heads longer than the body height are those with the highest carcass yield. (Sanget al.,2009) also report that body measurements were effective in the estimation of weight and body yield in catfishPangasianodonhypophthalmus.

CONCLUSION

The standard length, head length and body width measurements by the direct effect and body length, fork length and snout length measures by the indirect effect were are important for determining the body weight of male *Capoetatrutta.*this morphometric could be used in breeding programs as a measure of direct selection for fish with better body weight traits, but at first, it is necessary to conduct a genetic study to provide information about the heritability and genetic correlation of this variable with the body weight.



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